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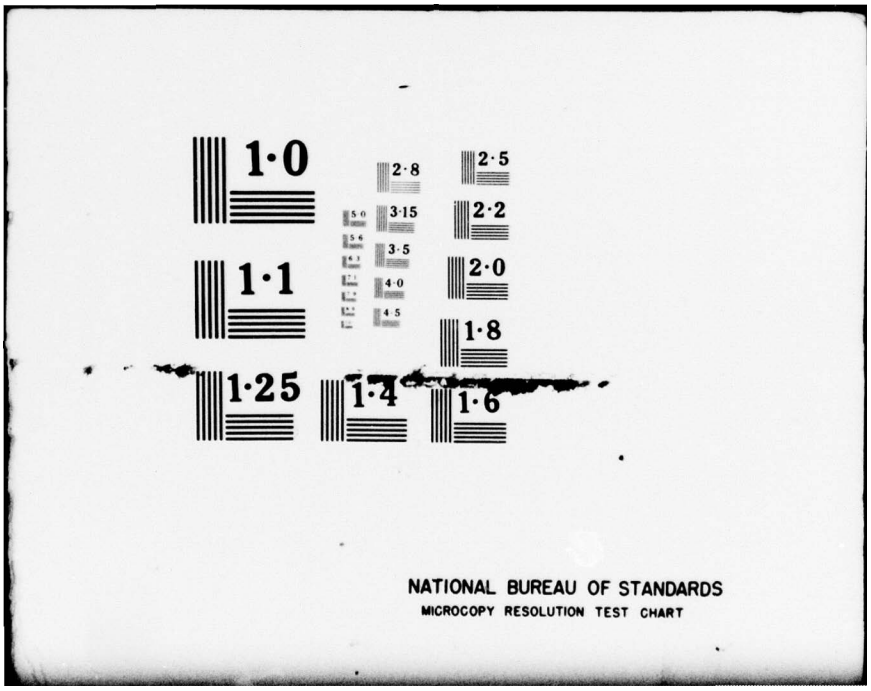
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MILITARY APPLICATIONS OF LASERS

by

N. Ushakov, M. Georgiyev

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MILITARY APPLICATIONS OF LASERS

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In the foreign press it is reported that an on-board night-time system for reconnoitering ground objects with a gas laser with a power of 20 mW with a resolution of 1 mrad and a scanning angle of 30-40° has been developed. This comparatively low power makes it possible to obtain high-quality photographs from an altitude of 450-900 m with a carrier flight speed of 550 km/h. It is also reported that a system with an emissive power of 0.2 W, a resolution of 0.3 mrad, and a scanning angle of 50° with a carrier flight speed of 1100-220 km/h has been developed.

The use of laser stations for illumination, especially on board remote-controlled vehicles in combination with instruments for night-time observation and television equipment for reconnoitering and targeting appears to be promising.

One of the systems which has been developed, for example, includes a compact gyrostabilized television system connected with a laser unit for illumination. The television camera of the system has a variable-focus objective lens which makes it psooible to obtain a field of vision of from 5° to 20°. An aluminum-yttrium garnet laser generates pulses lasting 20 ns and an energy of 50 mj. The laser illumination unit is intended

~~and and energy of 50 mj. The laser illumination unit is intended~~ to be combined with an infrared unit for observing the area in the dark.

The development of a night sight for helicopters, tanks, and ground transportation which is capable of operating both in a passive mode and in an active mode with a pulse laser for illuminating the target and determining the distance to it also has been reported.

FOR WEAPON CONTROL

Laser command systems, laser ray aiming systems, and semi-automatic aiming systems with laser illumination of the target are used in foreign countries.

The AN/AVQ-10 aircraft system, which the Americans used in Viet Nam, is designed for aiming aerial bombs with electronic-optical heads for homing in on bridges, antiaircraft missles and artillery, tanks, individual weapons, fuel tanks, and other entrenched defensive positions.

Stabilization of the line of sight of the laser unit for illumination in combination with a television camera and an indicator is used in this system. Aiming the bombs with the use of lasers ensures high accuracy of striking the target (the

error is 3-5 m, while the usual bombs have an error of 90-120 m).

Systems for target illumination both for independent operation of an aircraft and for dual operation have been developed in foreign countries. In the latter case the target is illuminated from the carrier which, as a loiterer outside the zone of fire of the anti-aircraft artillery, ensures that the laser beam will be held on the target. The light reflected from the target strikes the receiving cell of the head for homing the bomb, which is dropped from the attack aircraft.

According to information in the American press, developments connected with the use of pilotless aircraft and miniature, remote-controlled aircraft as carriers of the illumination unit have begun. These are equipped with apparatus for locating targets and transmitting the images to the control point by television.

In the opinion of the American experts these methods ensure the achievement of the goal of direct air support with minimum losses, since the miniature aircraft have a small radar reflecting cpaacity and consequently are hard to hit with antiaircraft weapons.

Units for illumination of a target from a helicopter or from a ground observation post for directing aircraft also are

being developed. The development of a laser target indicator mounted on a tripod or stand (portable) which is designed for aiming guided missiles with a semi-automatic laser aiming system is envisioned. The forward aircraft controller, who mans the illumination unit, finds the target and radios the pilot of the airplane or helicopter equipped with rockets. The aircraft makes a bombing run, and the controller illuminates the target with the laser beam. After the homing head acquires the target the rocket is launched.

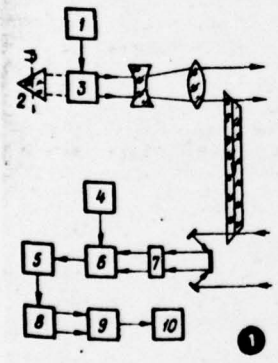

Fig. 1. Structural diagram of a pulse laser distance finder; 1 - pumping lamp; 2 - quality modulator; 3 - ruby; 4 - dynamic amplification regulator; 5 - preamplifier and pulse former; 6 - photoelectric multiplier; 7 - interference filter; 8 - trigger; 9 - gate circuit; 10 - indicator.

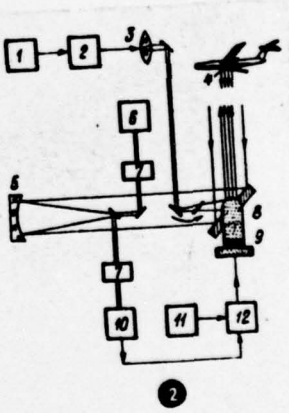

Fig. 2. Structural diagram of a location system with automatic tracking: 1 - gas laser; 2 - modulator; 3 - collimator; 4 - reflector; 5 - parabolic mirror; 6 - photomultiplier of the distance unit; 7 - filters; 8 - flat mirror; 9 - tracking system; 10 - disector; 11 - manual control equipment; 12 - servosystem.

The principle of semi-automatic laser aiming also is used in the development of guided artillery shells and rockets of

the ground-ground type designed for attacking tanks, armored transporters, reinforced bunkers, and other objects.

IN COMMUNICATIONS

Laser systems, which have two basic advantages over radio communication systems - precise aiming of the beam and a wide band of transmission frequencies -, are used in communications.

The directivity of the emission of a laser system with a forming lens is characterized by stability of the angle of expansion in seconds of arc. This practically excludes the possibility of interception of the information transmitted. According to the method of receiving optical signals there are two basic types of laser communications systems. Optical heterodyning (photomixing) is used in system of the first type. The signals received are mixed with the emission of the local oscillator and then the pulses of different frequency are separated. The useful information is extracted after rectification of the signal. Direct rectification of the laser signals received is performed in systems of the second type. The receiver reacts only to variation in the intensity of the carrier frequency and the entire information on the optical frequency and phse is lost.

As a receiving method photomixing has potential advantages

over direct detection. However, its realization requires spacial orientation of the wave fronts (the angle between the heterodyning fronts and the signal beam must be no larger than 10^{-4} rad).

Modulations of several types are used for forming laser signals in the transmitters of communications systems: amplitude (according to the intensity), frequency, phase, polarization, and pulse-code.

The structure of the laser communications system is determined by the purpose of the system. Pulse systems with direct detection are preferred in short ground lines since they are least sensitive to atmospheric disturbances. Their operating distance usually is limited by the line of sight.

Special investigations were carried out in foreign countries in order to evaluate the influence of the atmosphere on laser communication lines. Testing of a helium-neon laser has shown that the attenuation of the emission along the ground surface is 10 db/km with good visibility, 15 db/km in fog, and 100 db/km in thich fog.

Closed light-conducting communications lines, which guarantee insignificant loss of energy and are used for short distances in multichannel transmission lines, are being developed in order to eliminate the influence of meteorological conditions

on communication lines.

The advantages of laser lines for long-distance communication can be realized most fully in the upper layers of the atmosphere and in space, where the attenuation of the rays is insignificant.

IN NAVIGATION

Laser gyroscopes are finding ever greater application in navigation. They are used in inertial systems for determining the reference directions of a moving object and receiving information about angular deviations of the object from the determined direction, and also for stabilization of the different on-board equipment of the moving object.

The laser gyroscope is an optical quantum generator with a finger-shaped resonator made in the form of a system of three and more mirrors which form a closed circle. Two independent oppositely directed optical travelling waves are generated in the resonator. Their frequencies depend on the speed of rotation of the finger-shaped resonator in the inertial space. The parameters of the resonator rotation may be determined according to the difference in the frequencies of the opposite waves.

In comparison with a mechanical gyroscope a laser gyro-

scope has higher sensitivity. It is not subject to the influence of the mass and the linear acceleration. It is possible to operate with great rotational speeds of the object itself up to 10^4 deg/sec). It is ready to operate after 1-2 s, and gains (is displaced) 5-6 seconds of arc per day. The values of these parameters are respectively three humdred and one and a half thousand times smaller than those in mechanical units.

AS AN OFFENSIVE WEAPON

At the present time lasers are not used as weapons of destruction. However, according to information in the foreign press, experiments and testing are being carried out in a number of capitalistic countries for developing such a weapon.

The action of this fundamentally new weapon is based on the high-power light emission of lasers. Upon receiving a high concentration of the energy of high-power lasers, which is guaranteed by the good directivity of the radiation, the material of objects is greatly heated from the outside, boils, and evaporates, which causes their destruction. According to the foreign experts, this weapon may find application in ground systems for antiaircraft and antimissle defense, and also to be included in the armament of aircraft and ships.

Great attention is being given to the development of gas hydro-

dynamic, electrodynamic, and chemical lasers, the emissive power of which reaches 200, 100, and 10 kW respectively in an uninterrupted mode.

According to the foreign experts there is the possibility of using laser weapons in armament complexes on aircraft and in particular on future bombers for combatting attacking aircraft and rockets of the "air-air" and "ground-air" type. It is proposed that laser weapons may be mounted on aircraft by the beginning of the 80's. It has been bound that it is necessary to guarantee an emissive power of no less than 2 mW in order to damage the skin of an airplane or rocket.

AS A COUNTER-ACTION WEAPON

Foreign countries are trying to apply lasers against laser distance finders, locators, communications systems, reconnoitering and weapon control.

As it is reported in the foreign press, tests of countermeasures against laser homing devices will be carried out. During these test the experts intend to determine how the efficiency of these devices can be reduced.

The possibility of using lasers which can counteract passive optical-electronic systems is being particularly explored

in foreign countries. United States Air Force and Navy experts intend to place the countermeasure system in a container suspended from an aircraft. The system includes a laser device for seeking out the optical system of the enemy discovering it by back-scattering of its input optics. In the case of the discovery of an enemy system, the laser device can generate blinding pulses for energy or information suppression of the optical system of the enemy.

Measures to increase protection against disturbances of laser systems are being taken. Experts in the USA are developing means of coding the radiation pulses in target illumination units, studying the possibilities of using tight-band filters in receiving channels, and also working to develop lasers which can be adjusted to waves of different duration. An adjustable laser with a pulse power of 1 mW, a pulse recurrence frequency of 10 Hz, and an adjustable band of 0.35-0.73 mm has been developed according to information in the press.

A characteristic feature of the contemporary stage of development of military laser technology in foreign countries is the transition form scientific research work to the creation of a number of test models of weaponry and equipment, some of which are being tested in test areas and in battle conditions.

In the future work will be carried out basically to increase

the efficiency of the generators, to increase the sensitivity of receiving units, and to reduce their weight, and also to solve the problems of aiming a tight laser beam at a target.

(taken from "Technology and Weaponry" with some small abbreviation)

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